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INSTRUCTION MANUAL

MODELS 97G AND 97H
TUNABLE DISCRIMINATOR

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ELECTRO-MECHANICAL RESEARCH, INC. SARASOTA, FLORIDA

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MODELS 97G AND 97H
TUNABLE DISCRIMINATOR

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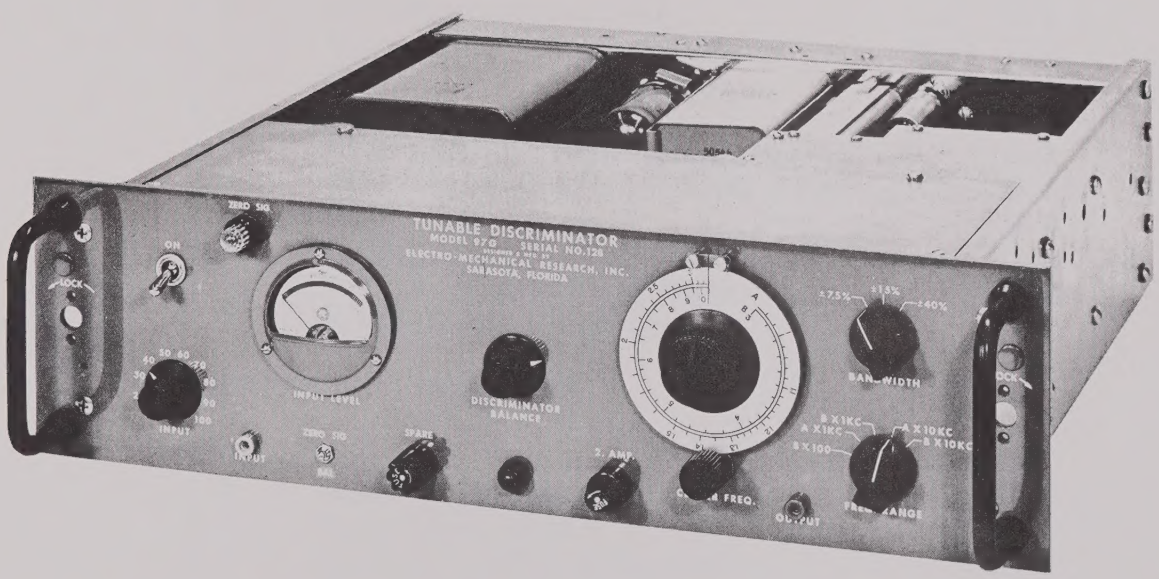

EMR MODEL 97 TUNABLE DISCRIMINATOR

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SECTION I
DESCRIPTION

1.1 GENERAL

The EMR Model 97 Tunable Discriminator is used to isolate any applied subcarrier in the 300-cps to 100-kc range and to discriminate the frequency modulation on this subcarrier. Complete removal of the subcarrier signal from the modulation is effected by the EMR Model 95 Variable Low-Pass Output Filter, which is designed for use with the Model 97.

Except for its switchable feature, the combination of Models 97 and 95 operates similarly to the EMR Model 67 and 189 Subcarrier Discriminators, and it provides most of the features of those discriminators.

The Model 97 provides excellent linearity of discrimination and minimal zero drift. Base-line limiting of the subcarrier signal entirely eliminates AM effects and reduces to a minimum the step-function changes normally caused by magnetic-tape dropouts.

Separation of the desired subcarrier is achieved by a tunable two-pole band-pass input filter whose characteristics have been designed for constancy of intelligence time delay throughout the pass band. Bandwidths of both ±7.5% and ±15% of the center frequency are provided over the entire range from 300 cps to 100 kc. For special cases where deviations as high as ±40% are required, a flat amplifier is substituted for the band-pass filter.

The Model 97 incorporates provisions for use with a tape-speed compensation system.

1.2 CHARACTERISTICS

The Model 97 Tunable Discriminator is designed for use with an EMR Model 95 Variable Low-Pass Output Filter. The specifications below are for both units as a system.

1.2.1 ELECTRICAL

Frequency Range: Center frequency is continuously tunable from 300 cps to 100 kc.

Frequency Deviation: Both ±7.5% and ±15% of center frequency. Input filter can be switched out for use with a subcarrier having a deviation of up to ±40%.

Rejection of Unwanted Signals: Capture ratio is such that a co-channel subcarrier can be as great as 90% of the desired subcarrier. In addition, the Model 95 Variable LPOF rejects beat frequencies between the desired subcarrier and the unwanted subcarrier which occur above its cutoff point. To these characteristics can be added the attenuation of the input filter in determining the rejection of modulation appearing on an adjacent-channel subcarrier. For example, the ±7.5% filter rejects by more than 60 db the modulation appearing on an adjacent subcarrier which is 6 db larger than the desired subcarrier.

Input-Filter Attenuation Characteristics: Attenuation of the band-pass input filter is greater than 12 db at the band edge of the nearest IRIG channel. Attenuation at band edge is 3±1 db for ±7.5% and ±15% deviations.

Input-Filter Tracking: The center of the band-pass input filter is within ±2% of the frequency indicated on the Center Freq. dial, as determined by the Freq. Range switch.

Time Delay of Input Filter: With ±7.5% deviation, time delay is equivalent to approximately 2 cycles of center frequency; with ±15% deviation, the delay is one half of the value for ±7.5% deviation. The total variation of time delay within each pass band does not exceed ±2.5 degrees of intelligence cutoff frequency based upon a deviation ratio of 5. This value of variation is inversely proportional to deviation ratio.

Input Signal Range: A minimum signal level of approximately 10 millivolts is required. Larger inputs can be attenuated by the Input control. The dynamic range of operation above a minimum signal is greater than 30 db.

Harmonic Distortion: Reduces data with a harmonic distortion of less than 1% for all intelligence frequencies up to IRIG-standard channel cutoff. As intelligence approaches dc, distortion decreases to 0.1% for ±7.5% channels and to 0.2% for ±15% channels.

Input Impedance: 0.1 megohm shunted by 20 μμf.

Amplitude Modulation and Tape Dropout: With the discriminator adjusted for operation at a deviation ratio of five, 50% square-wave amplitude modulation of the subcarrier results in an output-amplitude change equivalent to less than 1% of bandwidth. This effect decreases proportionately as deviation ratio increases.

Zero-Signal Protection: When signal is lost, the output assumes a preset value corresponding to any deviation within the pass band.

Linearity of Output vs. Subcarrier Frequency: Better than ±0.1% of full bandwidth, based on the best straight line, at ±7.5% deviation. At ±15% deviation, better than ±0.1% of FBW to 30 kc and better than ±0.2% to 70 kc.

Output Stability: ±0.5% of full bandwidth in a 15-hour period after a 15-minute warm-up.

Sensitivity Stability: ±0.25% of bandwidth.

Power Requirements:

Model 97G--175 watts at 105 to 125 volts unregulated, 60 cps.
Model 97H--160 watts at 105 to 125 volts unregulated, 55 to 70 cps, and 15 watts at 115 volts ±1%, 55 to 70 cps.

Tube Complement: 2 type 5V4GA, 2 type 6AW8, 1 type 6080, 1 type 5651WA, 5 type 6136, 3 type 6201, 4 type 6AU6, 1 type 6AL5, 1 type 5964, 2 type 5965.

1.2.2 MECHANICAL

Panel Size: 5 1/4 in. by 19 in.

Chassis Size: 16 3/8 in. wide by 16 1/8 in. deep.

Over-all Depth: 16 3/8 in. maximum.

Weight: 49 pounds.

Controls (all on front panel):

"Input" potentiometer
"Discriminator Balance" rheostat
"Freq. Range" switch
"Center Freq." rheostat (fine tuning)
"Bandwidth" switch
"Zero Sig. Bal." potentiometer
"On-Off" switch

Indicators: Pilot light indicates when power is on. "Zero Sig." bulb indicates no signal input.

Meter: "Input Level"

Test Points: "Input" and "Output" pin jacks (front panel)

Connector: Cannon type DPD-D32C2-34P-1L. Mates with Cannon type DPD-D32C2-33S-1L (supplied).

SECTION II
INSTALLATION AND OPERATION

2.1 GENERAL

The EMR Model 97 Tunable Discriminator is designed for use with a Model 95 Variable Low-Pass Output Filter. In combination, these units provide the ultimate in flexibility for demodulating FM subcarriers.

Interconnections between Models 97 and 95, as well as installation and operating procedures for the Model 97, are described below. Refer to the instruction manual for the Model 95 for installation and operation of that unit.

2.2 INSTALLATION

When slides are not used, the Model 97 can be mounted in the rack by means of angle brackets that support the unit on its side brackets.

When pullout, nonturnover slides and slide-mount hardware have been specified, a spacer bar having three screw holes is supplied on each side of the Model 97. After the slides have been installed in the rack, pull forward the innermost subassembly of the slides until the full-extention stop engages. Depress the stop button and completely withdraw this subassembly. Mount the subassembly to the spacer bar on the discriminator by means of the three No. 10-32 screws provided. Repeat this procedure for the other side of the discriminator, then insert the unit into the rack--again depressing the stop button.

When pullout, turnover slides and slide-mount hardware have been specified, a spacer bar having six screw holes and a helical insert is supplied on each side of the Model 97. After the slides have been installed in the rack, pull forward the innermost subassembly of the slides until the full-extention stop engages. Depress the stop button and completely withdraw this subassembly. Mount the subassembly to the spacer bar on the discriminator by means of the six Phillips screws provided. Use the indexing pin to locate the tilt mechanism in the 0^{o} (horizontal) position. Repeat this procedure for the other side of the discriminator, then insert the unit into the rack--again depressing the stop buttons. The tilt mechanism provides seven positions: 0^{o}, $\pm 45^{o}$, $\pm 90^{o}$, and $\pm 105^{o}$.

Secure the unit in the rack by means of the two twistlock fasteners located beside the handles.

2.3 COOLING

The physical construction of the Model 97 Tunable Discriminator is similar to that of most other EMR rack-mounting equipment. All power-consuming components are extended into a chimney area to allow for forced-air cooling from a blower mounted at the bottom of the rack. This design extends the useful life of components and contributes toward maximum dependability with a minimum of maintenance. Because of this EMR construction practice, almost any EMR rack-mounting equipment can be placed above or below the Model 97 without obstructing the chimney formed when a number of units are stacked in a rack.

2.4 ELECTRICAL CONNECTIONS

Refer to Figure V-1 for interconnections between the rear connectors of the Models 97 and 95. Wire the Cannon type DPD-D32C2-1L mating connectors accordingly. If the units have been supplied as part of an EMR system, the interunit wiring will have been accomplished at EMR.

The Model 97G operates from a 175-watt source of 105 to 125 volts unregulated, 60 cps. The Model 97H operates from a 160-watt source of 105 to 125 volts unregulated, 55 to 70 cps, and a 15-watt source of 115 volts ±1%, 55 to 70 cps.

Connect the unit to the proper power source(s), then turn the power switch on.

2.5 INPUT LEVEL CONTROL AND METER

The input potentiometer, R101, located on the front panel, attenuates large input signals to an optimum operating range for the band-pass input filter. This range is indicated by the green area of the Input Level meter. An input signal of 10 millivolts rms will result in proper discriminator operation, although with such signals the input level may be below the green area of the meter. If any amplitude variation of the signal is expected, it is preferable to operate near the middle of the green area. Blocking of the input filter occurs near the top of the meter scale. The dynamic range of operation is greater than 30 db.

The Input Level meter is connected at the output of the band-pass input filter, so that only the desired subcarrier is monitored. The signal level can be monitored remotely by connecting a 0-200 microammeter at pins 5 and 6 of the rear connector. A jumper must be placed across these pins when the external meter is not used.

2.6 CENTER FREQUENCY CONTROLS

Tuning to the center frequency of the desired subcarrier signal is accomplished with the Freq. Range switch and the Center Freq. dial on the front panel. Markings on the Freq. Range switch indicate which scale of the dial is being used. The lowest frequency available is 300 cps; the highest is 100 kc.

For fine tuning of a fixed-frequency signal, rotate the Center Freq. dial until a peak is obtained on the Input Level meter.

2.7 BANDWIDTH SELECTOR

The Bandwidth switch selects a band-pass input filter characteristic of ±7.5% or ±15% of center frequency. (See Figure V-2.) In the ±40% position a flat amplifier is substituted for the filter. The gain in each position of the switch is automatically adjusted so that the Input control setting need not ordinarily be changed when the Bandwidth switch setting is changed.

The Bandwidth switch also adjusts the output level of the trigger-circuit discriminator so that it is constant for the full deviation indicated by the setting of the switch.

2.8 DISCRIMINATOR BALANCE CONTROL

The coarse adjustment of the trigger-circuit discriminator is an automatic function of proper factory alignment of the band-pass input filter, but a fine adjustment is required to achieve an exactly centered output to the Model 95 Variable Low-Pass Output Filter. The Discriminator Balance control on the front panel of the Model 97 operates a ten-turn potentiometer, R320, which is a vernier adjustment of the tuning of the trigger-circuit discriminator. Proper adjustment of this control results in a square wave form, having no dc component, out of the trigger-circuit discriminator. A dc voltmeter at the output of the Model 95 or the Output meter of the Model 95 can be used to ascertain that there is no dc component in the signal.

2.9 ZERO-SIGNAL CONTROL AND INDICATOR

The Zero Sig. Bal control provides means for returning the discriminator output to any desired value within design deviation in the event that the subcarrier input is lost. The Zero Sig. light provides visual indication of loss of usable signal.

2.10 INPUT JACK

The Input jack at the lower left of the front panel provides means for observing the output of the band-pass filter on an oscilloscope. Any convenient spot on the chassis can be used for a ground connection. Because this test point is in the Input Level meter circuit, it is not a measure of the absolute output level of the filter. The Input jack is also connected to pin 27 of the rear connector.

2.11 OUTPUT JACK

A sample of the square wave at the output of the Model 97 is available at the Output jack. The peak-to-peak amplitude of this signal is 1 volt. An oscilloscope having suitable bandwidth can be used to observe this signal.

2.12 TAPE RECORDER/REPRODUCER SPEED-ERROR COMPENSATION

When tape recorder/reproducer speed-error compensation is to be applied to the Model 97, pin 22 of the rear connector should be removed from ground and connected to the output of the compensation system.

SECTION III
THEORY OF OPERATION

3.1 GENERAL

The EMR Model 97 Tunable Discriminator consists of a band-pass input filter, a limiter, a pulse generator, a trigger-circuit discriminator, a zero-signal clamping circuit, an output amplifier, and a power supply. The unit is designed for use with an EMR Model 95 Variable Low-Pass Output Filter. Figure V-3 is a block and wave-form diagram of Models 97 and 95. Figure V-4 is the schematic of the main chassis of both versions of the Model 97 (97G and 97H). Figure V-5 is the schematic of the power supply of the Model 97G. Figure V-6 is the schematic of the power supply of the Model 97H.

3.2 BAND-PASS INPUT FILTER

The band-pass input filter consists of two electronic filter networks forming a two-pole filter characteristic. Resonant properties of these networks are obtained from bridged-T networks composed of fixed precision capacitors and ganged variable resistors. Separate banks of capacitors are used for ±7.5% and ±15% deviations. Figure V-2 illustrates representative attenuation curves for these filters.

The input impedance of the band-pass input filter is 100,000 ohms. As a result, a large number of discriminators operating on different channels can be paralleled.

3.3 INPUT LEVEL METER

The signal from the output of the band-pass input filter is applied through dropping resistor R200 to the bridge rectifier circuit consisting of diodes D101 and D102 and resistors R219 and R220. The Input Level meter is the galvanometer element in the bridge circuit. Normally, pins 5 and 6 on P1 are jumpered. When an external meter is used, the jumper is removed and the external meter is connected to pins 5 and 6, thereby removing the Input Level meter from the circuit.

3.4 LIMITER AND PULSE GENERATOR

The output of the band-pass input filter is applied to the limiter stage (V201, V202, and V203) which provides a square wave to the pulse-forming stage, V301. The pulse from V301 triggers the discriminator stage at the plate of V302.

The limiter stage produces a square wave whose positive excursion occurs simultaneously with the zero-axis crossing in the positive-going direction by the input sine wave. The circuit associated with V201 is designed to provide large amplification of the input sine wave for plate excursions of approximately ±20 volts. Beyond this excursion range, one of the diodes associated with V202 conducts and reduces the gain of V201 to approximately unity, thus preventing any further large plate excursions. The signal on the plate of V201 approximates a square wave whose sides coincide with the zero-axis crossing of the input sine wave. This approximate square wave then triggers a cathode-coupled bistable multivibrator, V203. The output of this trigger circuit is taken from the unloaded plate of V203B which, because of the cathode coupling, is free from capacity and therefore produces a good square wave.

Since the limiter triggers only when the incoming sine wave crosses the zero axis, the output is not affected by variation in input signal levels over the entire linear range of the band-pass input filter. Limiting occurs when there is from 0.4 to 1.0 volt rms on the cathode of V153A, and the filter output remains linear to at least 35 volts rms; this provides a dynamic input range greater than 30 db. This wide dynamic input range enables the limiter to reject large-scale amplitude modulation almost completely. When the input to the grid of V101 falls below approximately 10 millivolts, limiting fails and the discriminator becomes inoperative. The Zero Sig. light on the front panel illuminates when the latter condition exists.

The limiter output is applied to V301 through the pulse-forming circuit consisting of C209 and R301. Tube V301 is biased beyond cutoff so that the negative grid pulses do not appear at the discriminator stage. Each positive grid pulse triggers the discriminator stage through the plate coupling of V302.

3.5 TRIGGER-CIRCUIT DISCRIMINATOR

The circuits associated with V302, V303, and V304 constitute the trigger-circuit discriminator. This discriminator produces a rectangular wave swinging between +90 volts dc and −90 volts dc. The total period of this wave is equal to the subcarrier period, but its negative portion is timed by networks in the discriminator. The result is a varying dc component in the rectangular wave which has an exactly linear relationship to the instantaneous subcarrier frequency.

When there are no pulses from V301, the discriminator stage is inoperative, with V302 cut off and V304 conducting, by virtue of their respective grid- and cathode-return circuits. In this condition, diode V303A conducts and the plate voltage of V302 is fixed at approximately +90 volts through the resistance divider consisting of R307, R310, and R311. In this condition, the cathode of V303B is maintained at +90 volts. The circuit passes through one cycle of operation for each trigger pulse from V301, the pulse being applied directly to the plate

of V302 through diode V303A, cathode follower V303B, and the discriminator tuning capacitor, C182 to C186, to the control grid of V304. The pulse applied to the grid of V304 is maintained at a constant amplitude because diode V303A ceases conduction after the plate of V302 becomes more negative than −90 volts. With V304 thus cut off, its plate rises to approximately 160 volts, and positive grid bias is applied to V302 through R309. In this conducting condition the plate of V302 falls to approximately −170 volts while the cathode of diode V303A is maintained at approximately −90 volts by R310 and R311. This also maintains the cathode of cathode follower V303B at approximately −90 volts. The circuit remains in this condition for a specific constant time until the discriminator timing network charges sufficiently to start conduction of V304. The circuit then returns abruptly to the initial condition, where it awaits the next pulse from V301.

Thus, the ±90 volts on the cathode of V303B, corresponding to the two discriminator-circuit conditions, is dependent only on the precision of resistors R307, R310, R311, and the stable B+ and B− voltages, and not upon the conduction characteristics of tubes V302 or V304. Since V301 and V302 are completely cut off before receipt of a trigger pulse, these tubes do not affect the +90-volt condition of cathode follower V303B.

An adjustment of the output at center frequency is provided by resistor R320, which affects the time constant during which V304 is saturated and V302 is cut off following each trigger pulse. Resistor R320 is the Discriminator Balance control.

3.6 ZERO-SIGNAL CLAMPING CIRCUIT AND ZERO-SIGNAL LIGHT

When the subcarrier signal at the wiper of the Input potentiometer (R101) is too small for normal operation of the Model 97, the trigger-circuit discriminator becomes inoperative and V302 remains cut off. This is the "zero-signal" condition. The screen of V302 is connected to ground through R306, so it is at zero potential when the tube is cut off. When the tube is conducting, the average screen potential is approximately −70 volts. This screen voltage is applied to the grid of V305 through resistor R318. The cathode is at approximately −30 volts, as set by the resistive divider consisting of R329, R331, and R334. During normal operation the −70 volts applied to the grid of V305 maintains the tube in a "hard" cutoff condition, and thus the grid of the output stage is not clamped. However, during "zero-signal" conditions the grid of V305 is no longer held negative with respect to the cathode, and the conduction of the tube determines the plate potential and thus the grid potential of the output stage.

The output potential is adjusted by varying the suppressor-grid voltage of V305 which is determined by the setting of the Zero Sig. Bal. control, R334. A portion of the resulting screen current during "zero-signal" conditions flows through the Zero Sig. light and an NE-2D neon bulb.

3.7 OUTPUT STAGE

The output stage, V306, is a White cathode follower designed to drive the high cable capacitance encountered in connecting the Model 97 to the Model 95 Variable Low-Pass Output Filter.

3.8 POWER SUPPLY

The B– supply is electronically regulated by V5, V6, and V3B. Tube V5 supplies a fixed reference voltage for the regulator amplifier, V6 and V3B. Tube V3B is the current regulator for the B– supply.

The ripple content of the supply is extremely low due to a special bridge balance circuit incorporated in the screen circuit of V6B. Resistors R21 through R24 and capacitor C11 constitute this bridge circuit. This design provides a null in the ripple voltage of the B– supply.

The B+ supply is similar to the B– supply except that it is referenced from the B– supply. Tube V5 supplies the reference for the B+ supply, and the cathode of V4A is returned through R3 to the B– supply. The ripple voltage of the B+ supply is nulled through the resistance divider network consisting of R7, R8, and R9 located in the screen circuit of V4B. The filaments of tubes V4 and V6 are regulated to further increase the stability of B+ and B– supplies.

SECTION IV
TROUBLE-SHOOTING AND MAINTENANCE

4.1 INSPECTION

The EMR Model 97 Tunable Discriminator should be subjected to a regular inspection program similar to that recommended for other types of electronic equipment. A visual inspection should be made each week, checking for loose components and evidence of overheating. A complete inspection every six months should include the following:

a. Test all vacuum tubes.
b. Tighten all external screws.
c. Inspect wiring for loose connections and signs of overheating.
d. Check all tube-socket voltages.
e. Check performance.
f. Replace defective components.

4.2 VOLTAGE MEASUREMENTS

Use chassis ground as reference for all dc and ac voltage measurements. Tube-socket voltages are listed in Figure V-7.

4.3 PERFORMANCE TESTS

The performance of the Model 97 can be determined with the tests described below. The inspection record may be used in conjunction with these tests. An audio-frequency oscillator, a vacuum tube rms voltmeter, an input attenuator, an oscilloscope, accurate means for measuring 0 to 30 milliamperes dc and 0 to 100 volts dc, and equipment for measuring frequency to within 0.02% should be used for these tests. Place the Model 97 in operation in accordance with the procedures given in Section II.

The location of tubes and component cards is shown in Figures V-8 and V-9.

4.3.1 GAIN AND FREQUENCY CHARACTERISTICS OF BAND-PASS INPUT FILTER

The output of the band-pass input filter can be measured at pin 3 of V153A, using a high-impedance probe having a capacitance of less than 15 μμf. The output of the first filter section appears at pin 8 of V103A. Refer to Figure V-2 for typical attenuation curves.

The gain of the band-pass input filter at center frequency is approximately 100. Each section has a gain of approximately 30; however, an attenuator between the sections has a 10:1 ratio.

4.3.2 LIMITER OPERATION

The output of the limiter can be observed at pin 2 of V203. It should be a rectangular wave swinging between +70 and +200 volts. Some limiting action is provided by the combination of amplifier V201 and the two diodes in tube V202. The output of this amplifier-diodes combination is observable at pin 5 of V201. As the input signal increases, the top and the bottom of the output are flattened. The level of the top is approximately +120 volts; the level of the bottom is approximately +80 volts.

4.3.3 OUTPUT OF TRIGGER-CIRCUIT DISCRIMINATOR

The output of the trigger-circuit discriminator can be observed at pin 8 of V303B. This signal is a rectangular wave swinging between approximately −90 volts and +90 volts. When the input signal to the discriminator is removed, the voltage at pin 8 of V303B remains fixed at +90 volts.

The timing wave of the trigger-circuit discriminator appears at pin 1 of V304. The timing pulse goes from the level of −200 volts to −400 volts, and V304 is cut off. When the timing circuit has returned the potential at pin 1 to −200 volts, V304 conducts and the timing period is completed.

4.3.4 OUTPUT OF THE MODEL 97

The output of the Model 97 Tunable Discriminator for low-frequency signal inputs is a rectangular wave swinging between approximately +90 and −90 volts when the unit is set at ±7.5% deviation; the wave swings between +45 and −45 volts at ±15% deviation and between +17 and −17 volts at ±40% deviation. The amplitude decreases as a function of input subcarrier frequency, beginning at approximately 10 kc until it is approximately one-tenth of the values given above at 100 kc. The average dc value of the output should vary between approximately +7 and −7 volts, depending upon where the input signal frequency is within the pass band and upon the setting of the Discriminator Balance control.

Under "zero-signal" conditions the dc output is determined by the setting of the Zero Sig. Bal. control and is within the range between approximately +7 and −7 volts.

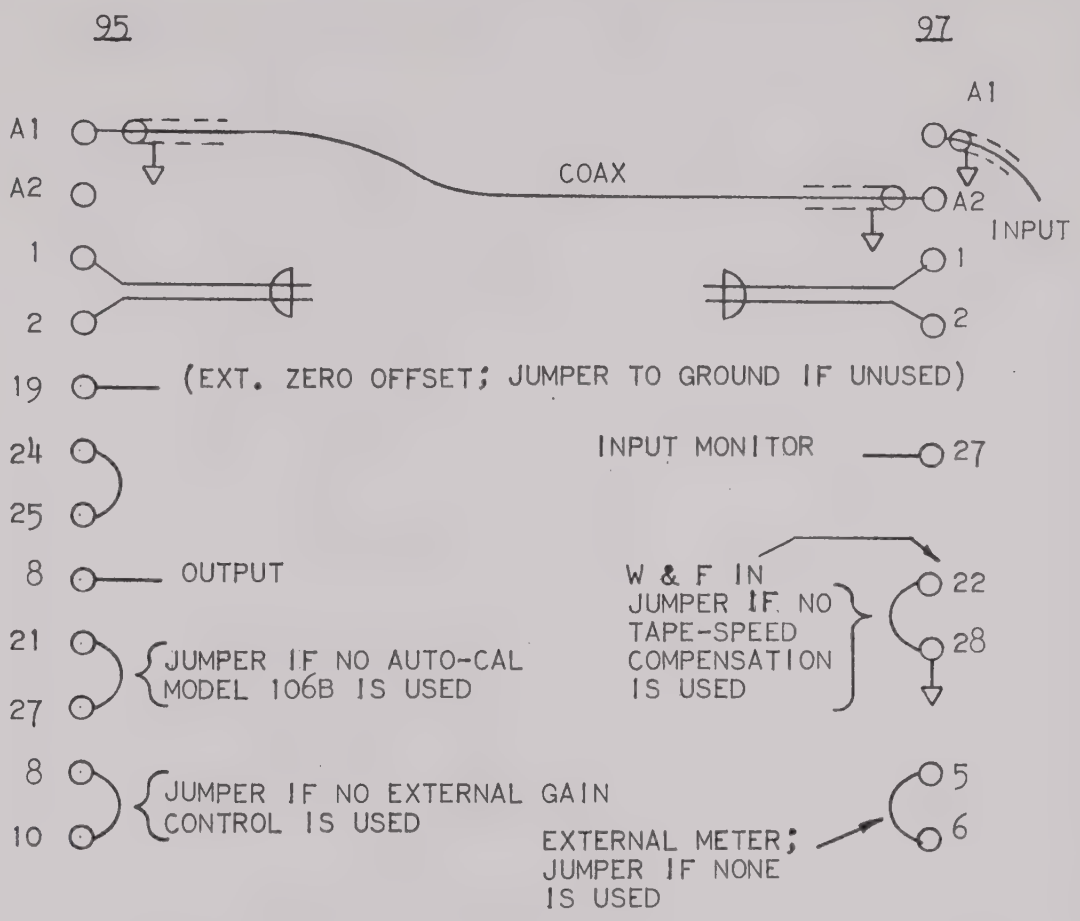
4.3.5 POWER SUPPLY

The B+ and B– supply voltages can be observed at capacitors C13 and C14, respectively. The B+ and B– voltages should be between 190 and 210 volts. Ripple voltage on either should be less than 4 millivolts rms. If the ripple exceeds this figure, tube V4 or V6 should be changed.

Over the range from 105 to 125 volts rms, the regulation of the regulated heater windings should be within the limits given on the circuit schematics.

SECTION V

TABLES AND DRAWINGS



NOTE: 3-4 (ON EACH UNIT) SHALL BE CONNECTED TO EXTERNAL REGULATOR IF DUAL PRIMARY POWER TRANSFORMERS ARE USED.

J		E		DATE 5-12-61	ELECTRO-MECHANICAL RESEARCH INC.
I		D		SCALE	
H		C		DRAWN RJB	
G		B		CKD. [illegible]	
F		A		APP.	INTERCONNECTIONS, 97G/H TO 95D/F A-08547
REVISIONS					

FIGURE V-1

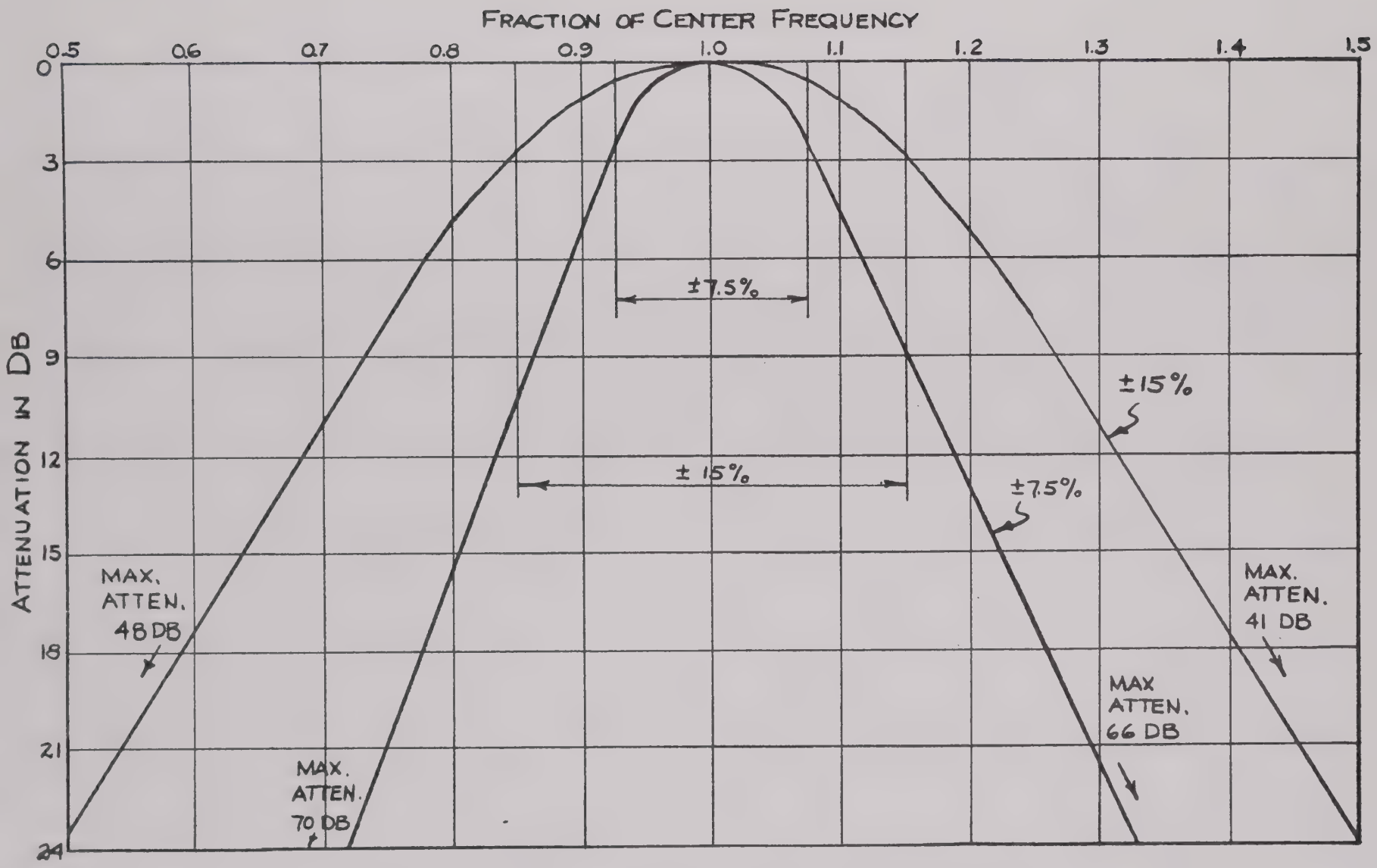


FIGURE V-2 BPIF ATTENUATION CHARACTERISTICS

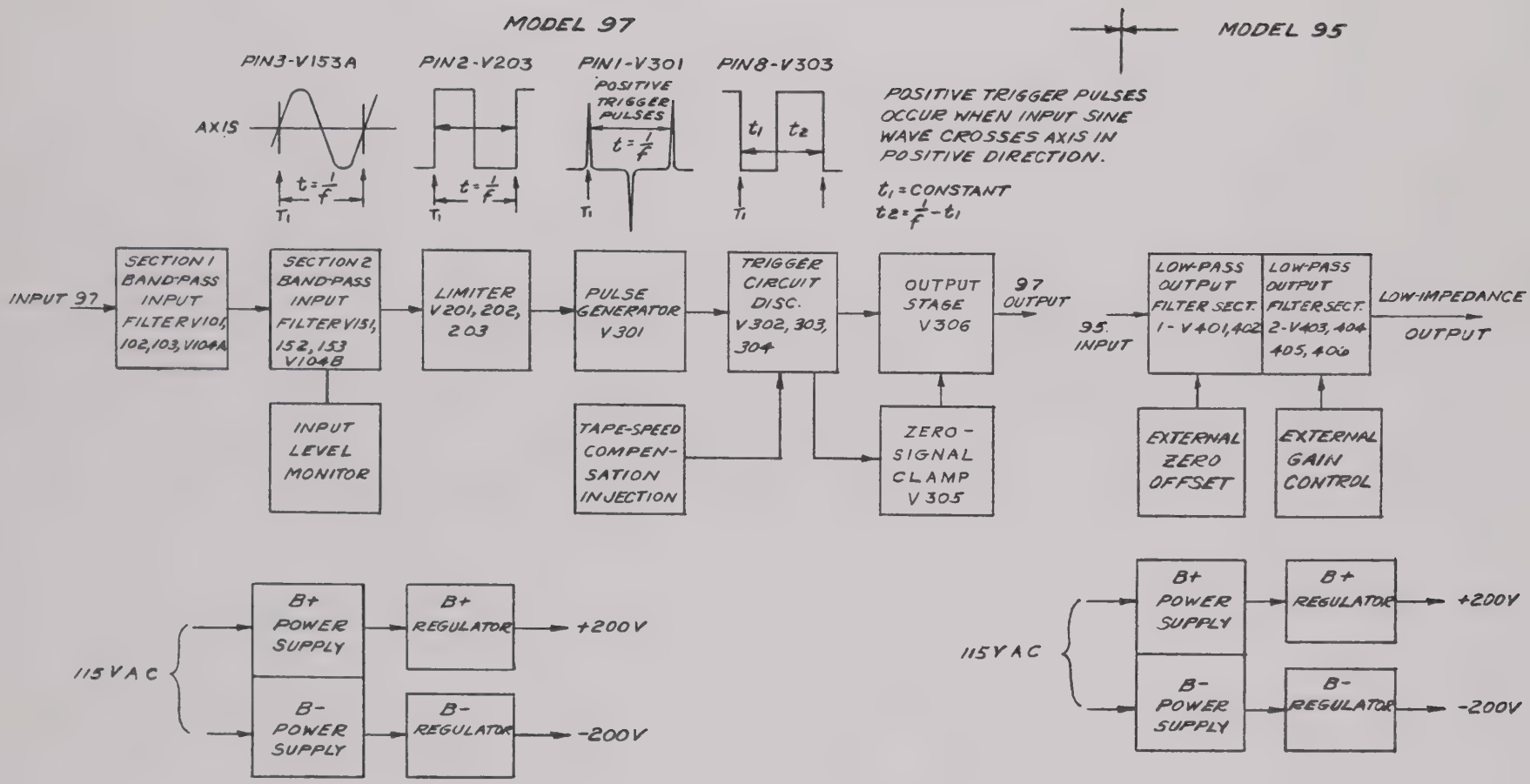

MODEL 97
MODEL 95
PIN3-V153A
PIN2-V203
PIN1-V301
PIN8-V303
AXIS
POSITIVE TRIGGER PULSES
POSITIVE TRIGGER PULSES OCCUR WHEN INPUT SINE WAVE CROSSES AXIS IN POSITIVE DIRECTION.
t1 = CONSTANT
t2 = 1/f - t1
INPUT 97
SECTION 1 BAND-PASS INPUT FILTER V101, 102, 103, V104A
SECTION 2 BAND-PASS INPUT FILTER V151, 152, 153 V104B
LIMITER V201, 202, 203
PULSE GENERATOR V301
TRIGGER CIRCUIT DISC. V302, 303, 304
OUTPUT STAGE V306
97 OUTPUT
INPUT LEVEL MONITOR
TAPE-SPEED COMPENSATION INJECTION
ZERO-SIGNAL CLAMP V305
95 INPUT
LOW-PASS OUTPUT FILTER SECT. 1 - V401, 402
LOW-PASS OUTPUT FILTER SECT. 2 - V403, 404 405, 406
LOW-IMPEDANCE OUTPUT
EXTERNAL ZERO OFFSET
EXTERNAL GAIN CONTROL
115 VAC
B+ POWER SUPPLY
B+ REGULATOR
+200V
B- POWER SUPPLY
B- REGULATOR
-200V
115VAC
B+ POWER SUPPLY
B+ REGULATOR
+200V
B- POWER SUPPLY
B- REGULATOR
-200V

FIGURE V-3

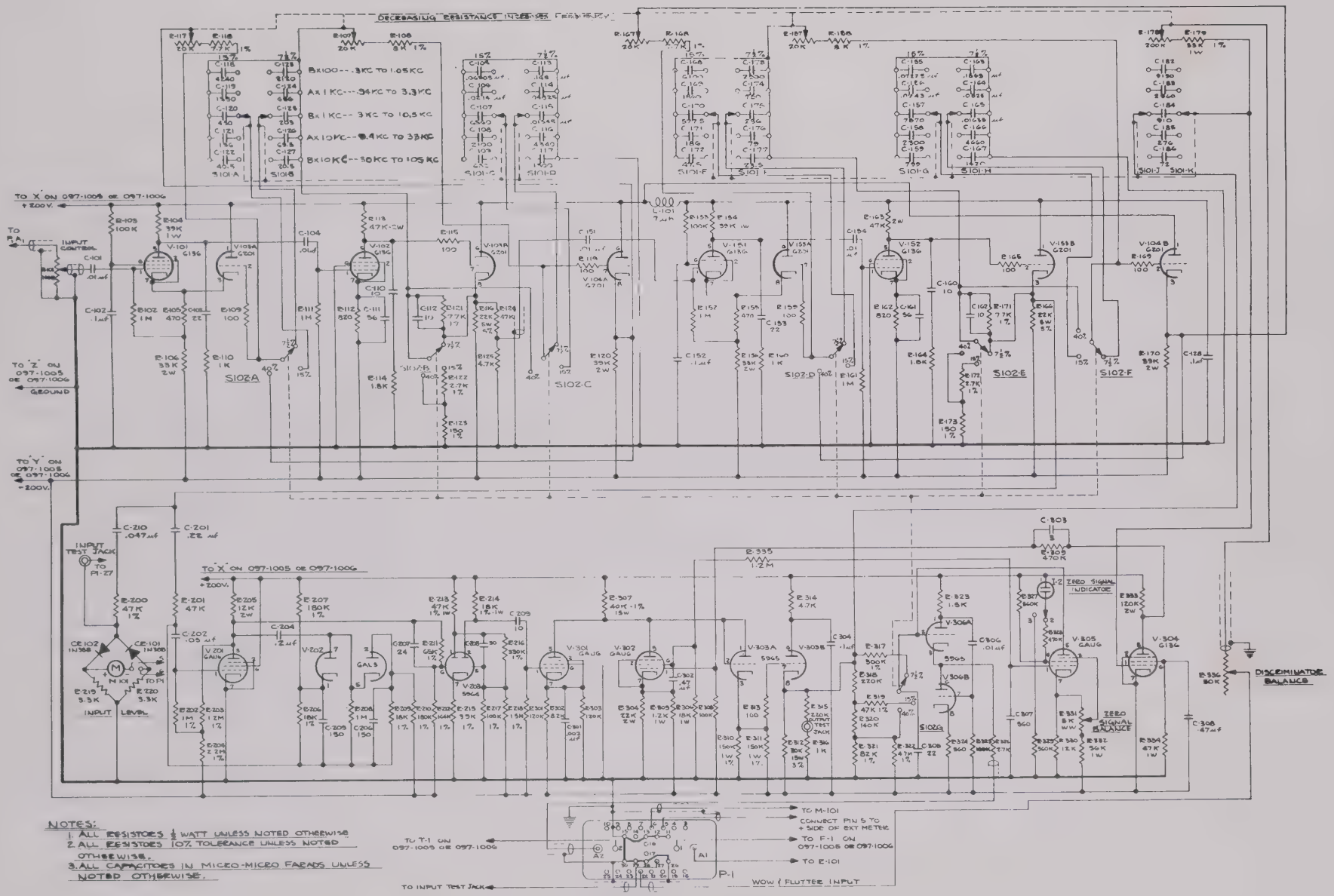
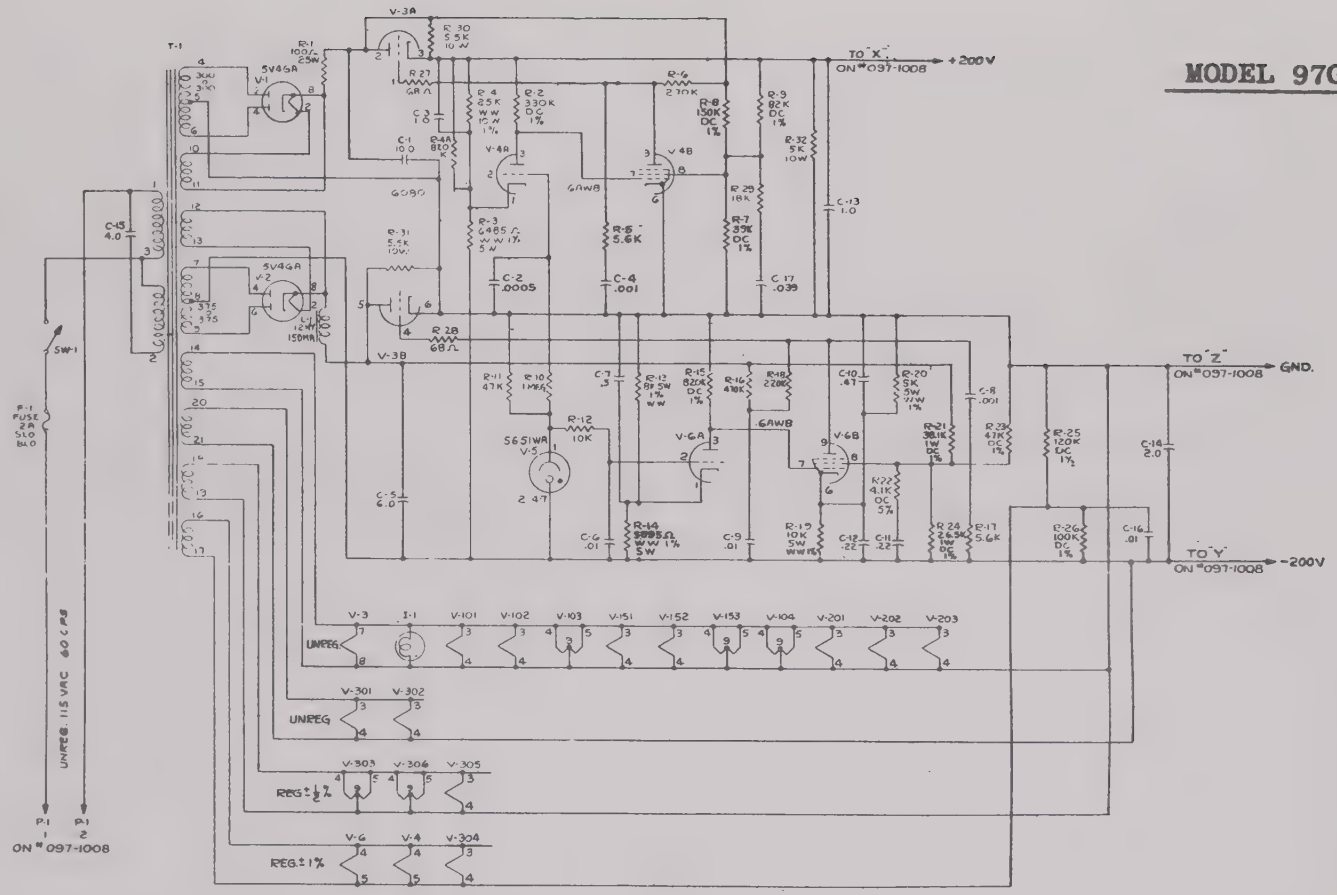

DECREASING RESISTANCE IN THESE LEGS PRODUCES
Bx100---.3KC TO 1.05KC
Ax1KC---.94KC TO 3.3KC
Bx1KC---3KC TO 10.5KC
Ax10KC---9.4KC TO 33KC
Bx10KC---30KC TO 105KC
S101-A
S101-B
S101-C
S101-D
S101-E
S101-F
S101-G
S101-H
S101-J
S101-K
TO 'X' ON 097-1005 OR 097-1006
+200V.
TO P1-A1
INPUT CONTROL
TO 'Z' ON 097-1005 OR 097-1006
GROUND
TO 'Y' ON 097-1005 OR 097-1006
-200V.
S102-A
S102-B
S102-C
S102-D
S102-E
S102-F
S102-G
INPUT TEST JACK
TO P1-Z7
INPUT LEVEL
GAIN
GAUG
J-2 ZERO SIGNAL INDICATOR
ZERO SIGNAL BALANCE
DISCRIMINATOR BALANCE
TO M-101
CONNECT PIN 5 TO + SIDE OF EXT METER
TO F-1 ON 097-1005 OR 097-1006
TO E-101
TO T-1 ON 097-1005 OR 097-1006
TO INPUT TEST JACK
WOW & FLUTTER INPUT
P-1
NOTES:
1. ALL RESISTORS ½ WATT UNLESS NOTED OTHERWISE.
2. ALL RESISTORS 10% TOLERANCE UNLESS NOTED OTHERWISE.
3. ALL CAPACITORS IN MICRO-MICRO FARADS UNLESS NOTED OTHERWISE.

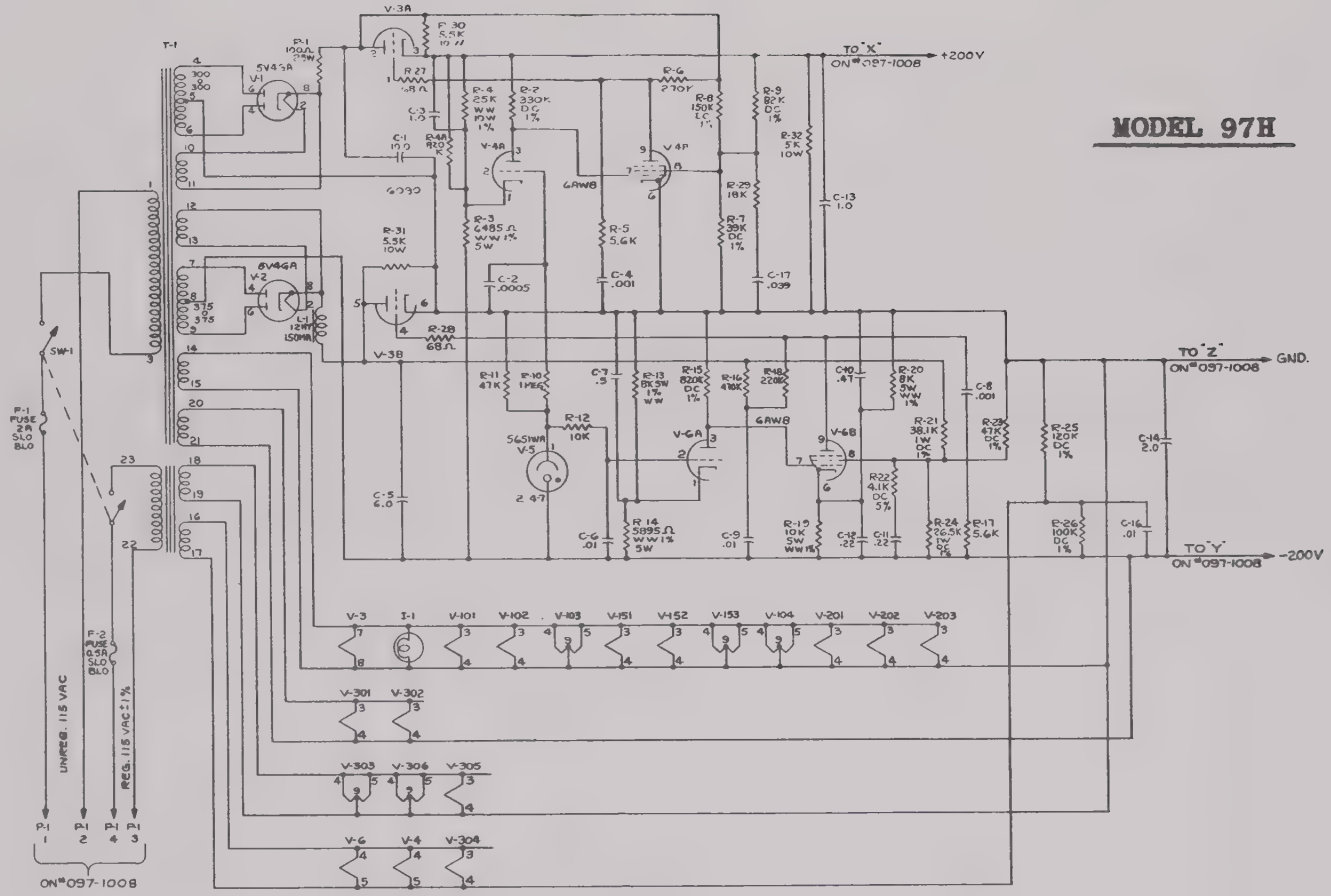
FIGURE V-4

MODEL 97G



NOTE:
ALL CAPACITOR VALUES ARE μf UNLESS OTHERWISE NOTED.

FIGURE V-5



NOTE:
ALL CAPACITOR VALUES ARE μf UNLESS OTHERWISE NOTED.

FIGURE V-6

TUBE SOCKET VOLTAGES

MODEL 97

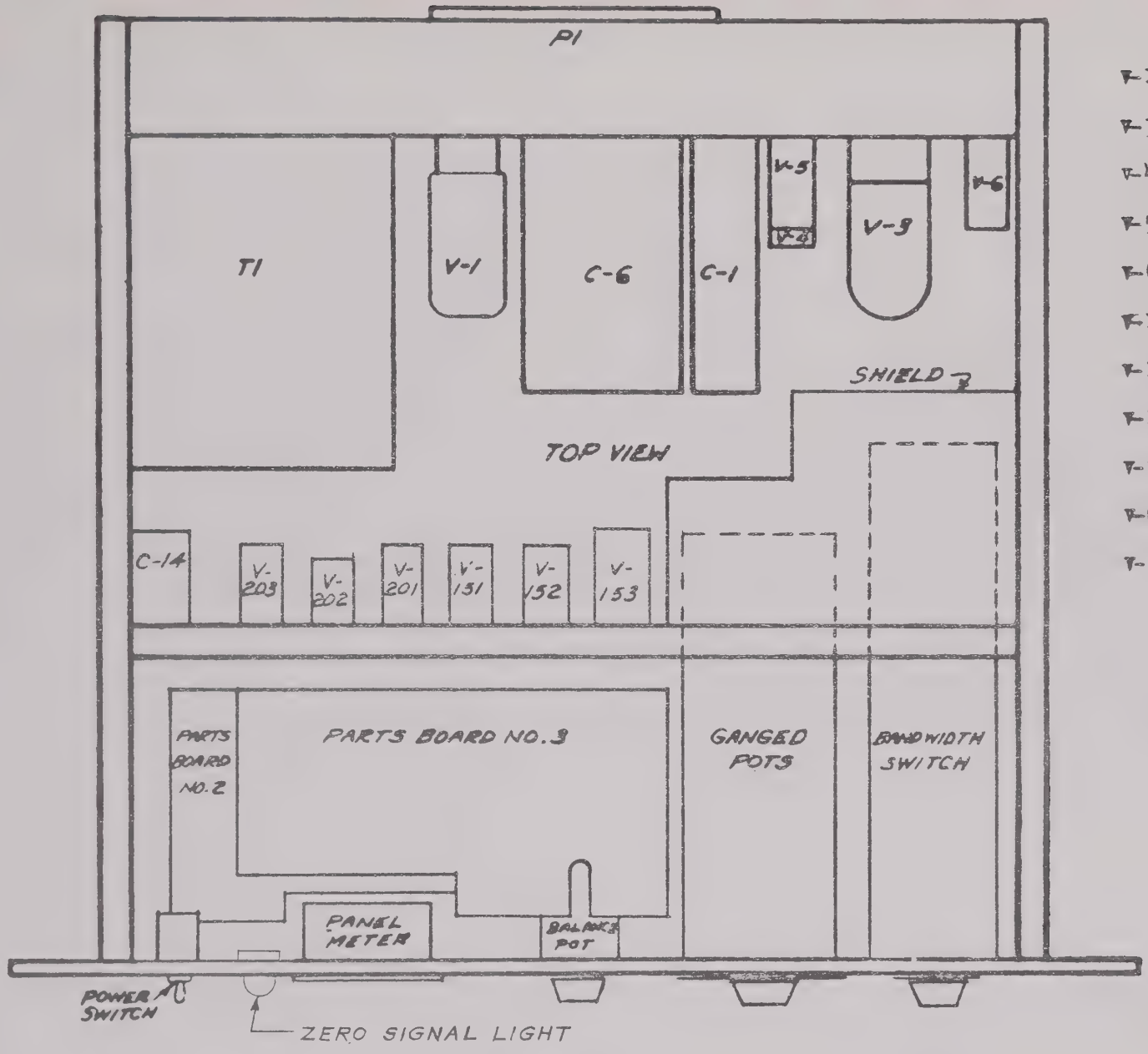
TYPICAL DC VOLTAGES

Tube	1	2	3	4	5	6	7	8	9
V1	0	+350	0		0		0	+350	
V2	0	+117	0		0		0	+115	
V3	+150	+350	+200	-22	+90	0			
V4	-110	-111	-4			0	-4	+110	+142
V5	-111	-200		-200	-111		-200		
V6	-110	-111	-88			-85	-88	-60	-22
V101	+6	+9.6			+135	+131	+9.6		
V102	-181	-194			+6.5	0	-194		
V103	+195	+7.5	+9.2			+195	+5.2	+6	
V104	+195	+13.5	+15.5			+195	+6	+7.5	
V151	+13	+17.2			+138	+134	+17.2		
V152	-181	-194			+13	0	-194		
V153	+195	+12	+13.2			+195	+14.5	+16.5	
V201	-2.6	0			+105	+195	0		
V202	+16	-23			-3.5	-4.4	-3.5		
V203	+136	+136			+12.	+8	+21		
V301	-200	-190			-35	0	-190		
V302	-190	-180			-35	-70	-180		
V303	-35	-35	-5.2			+160	-5.2	-3	
V304	-240	-200			-38	-150	-200		
V305	-63	-40			-2.5	+182	-32.5		
V306	+180	-2.7	+0.4			+0.4	-196	-193	

AC Volts

V-1		310		310	
V-2		375		375	

FIGURE V-7



V-1	-	5V4GA
V-3	-	6080
V-4	-	6AW8
V-5	-	5651
V-6	-	6AW8
V-151	-	6136
V-152	-	6136
V-153	-	6201
V-201	-	6AU6
V-202	-	6AL5
V-203	-	5964

FIGURE V-8

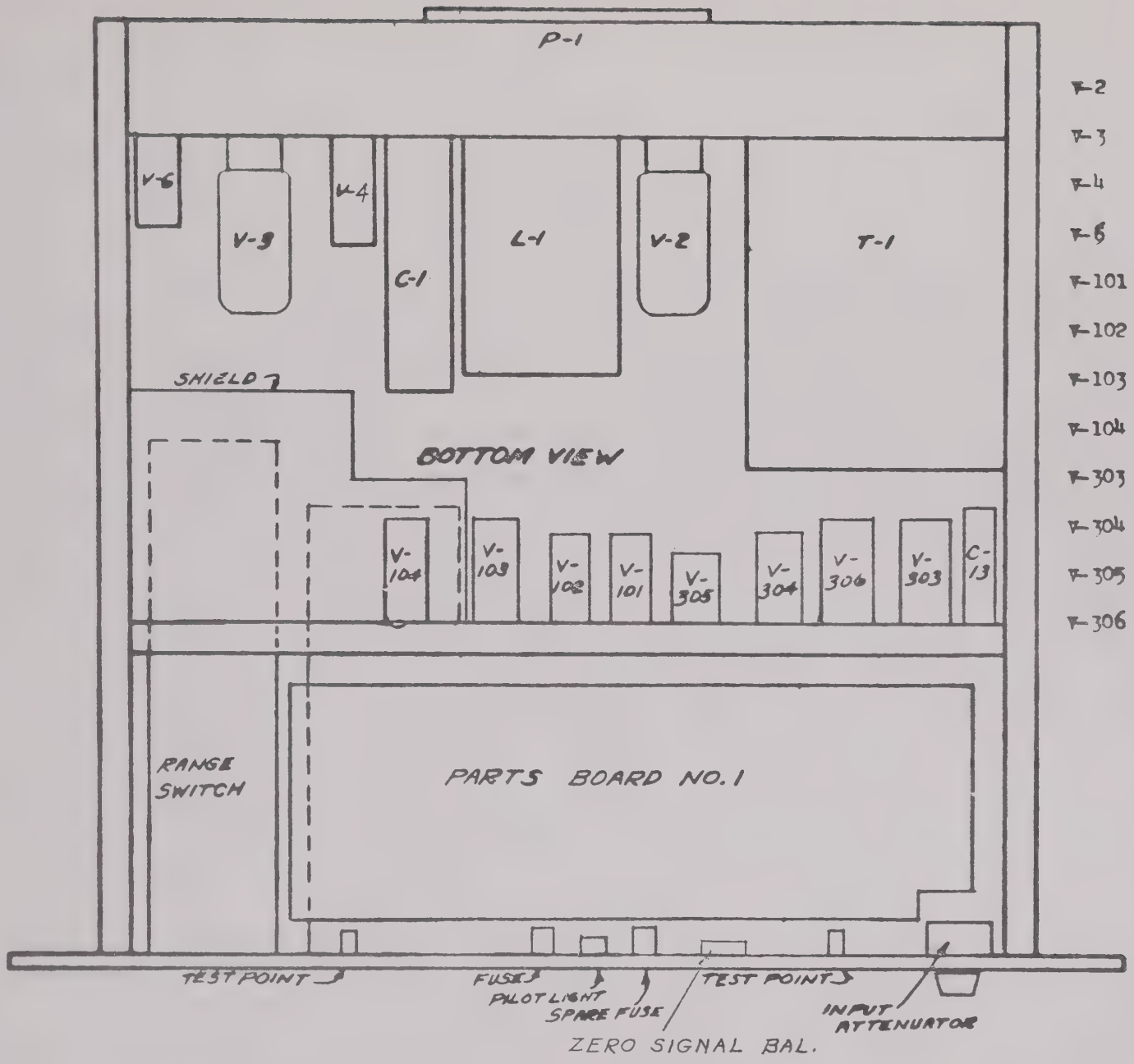

P-1
V-6
V-3
V-4
C-1
L-1
V-2
T-1
SHIELD
BOTTOM VIEW
V-104
V-103
V-102
V-101
V-305
V-304
V-306
V-303
C-13
RANGE SWITCH
PARTS BOARD NO. 1
TEST POINT
FUSE
PILOT LIGHT
SPARE FUSE
TEST POINT
INPUT ATTENUATOR
ZERO SIGNAL BAL.
V-2 - 5Y3GA
V-3 - 6080
V-4 - 6AW8
V-6 - 6AW8
V-101 - 6136
V-102 - 6136
V-103 - 6201
V-104 - 6201
V-303 - 5965
V-304 - 6136
V-305 - 6AU6
V-306 - 5965

FIGURE V-9

SECTION VI

REPLACEABLE SPARE PARTS

TERMINOLOGY; WARRANTY; ORDERING INFORMATION

All electrical and all critical mechanical parts used in this equipment are itemized on the following pages. Prices will be quoted upon request.

Those items designated "PP" (parts peculiar) are manufactured by or specially for Electro-Mechanical Research, Inc. Those items designated "LL" (long lead) are items which require over sixty (60) days but not more than one hundred eighty (180) days to obtain. Those items designated "QC" (Quality Control) are items which are purchased by EMR and tested to EMR specifications necessary to ensure proper operation of this equipment. Field spares are those items recommended for support of the equipment in locations where complete stock facilities are not practical.

In order to ensure availability of those parts marked "PP," "LL," or "QC," earliest possible ordering is recommended. All orders should indicate the EMR part number.

All materials employed in EMR equipment are of the best quality; however, the reliability of component parts can not be predicted or guaranteed for an indefinite period. This equipment, with the exception of batteries, tubes, and fuses, is fully guaranteed for a period of thirty (30) days following the date of shipment.

Should any questions arise concerning this parts list, please do not hesitate to call upon Electro-Mechanical Research, Inc., in Sarasota, Florida, or any EMR field office.

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Phone 958-7731 TWX SARASOTA 6006

EMR MODEL No. 97G & H

DATE 6/30/61
REVISION

Provisioning Spare Parts List

ITEM NO	CIRCUIT SYMBOL NO.	STOCK NUMBER	DESCRIPTION	MANUFACTURER NAME	MANUFACTURER PART NO.	EMR PART NO.	QTY IN EQT	RECOM'D 6 MO. BASE SPARES	RECOM'D 6 MO. FIELD SPARES	PP-PART PECULIAR LL-LONG LD		REMARKS
	C1		Capacitor, fixed, paper, 10 µf ±10%, 600V	Sprague	CP70B1F-F106K	S97-001	1					
	C2		Capacitor, fixed, mica, 500 µµf ±5%, 300V	Elmenco	CM-15A	S97-002	1					
	C3		Capacitor, fixed, paper, 1 µf ±20%, 400V	Pyramid	7PGIHL	S97-003	1					
	C4 C8		Capacitor, fixed, mica, 0.001 µf ±10%, 500V	Elmenco	CM-19A	S97-004	2					
	C5		Same as C1 except 6 µf	Sprague	CP70B1F-F605K	S97-005	1					
	C6 C9 C16		Capacitor, fixed, mica, 0.01 µf ±10%, 500V	Elmenco	CM-35B	S97-006	3	0	1			
	C7		Capacitor, fixed, paper, 0.5 µf ±20%, 400V	Sprague	CP54B1E-E504M	S97-007	1					
	C10		Capacitor, fixed, paper, 0.47 µf ±20%, 300V	Pyramid	301-D1	S97-008	1					
	C11		Capacitor, fixed, paper, 0.22 µf ±20%, 300V	Pyramid	PGHV	S97-009	1					
	C12		Capacitor, fixed, paper, 0.22 µf ±20%, 200V	Pyramid	PGIHV	S97-010	1					
	C13		Capacitor, fixed, paper, 1 µf ±20%, 400V	Tobe	OMB	S97-011	1					
	C14		Same as C13 except 2 µf	Tobe	OMB	S97-012	1					
	C15		Part of T1, which see.									Used only on 97G.
	C17		Capacitor, fixed, paper, 0.039 µf ±20%, 200V	Pyramid	PGHV	S97-013	1					

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	C101 C104 C151 C154 C306		Capacitor, fixed, paper, 0. 01 µf ±20%, 600V	Pyramid	EPGIHV	S97-014	5	1	1			
	C102 C152		Capacitor, fixed, paper, 0. 1 µf ±20%, 300V	Pyramid	PGIHV	S97-015	2					
	C103 C153 C305		Capacitor, fixed, mica, 22 µµf ±10%, 500V	Elmenco	DM-15	S97-016	3	0	1			
	C105		Capacitor, fixed, Mylar, 0. 06905 µf ±1%, 200V	Efcon	MHA	S97-017	1					
	C106		Same as C105 except 0. 214 µf	Efcon	MHA	S97-018	1					
	C107		Capacitor, fixed, mica, 6560 µµf ±1%, 500V	Elmenco	CM-35A	S97-019	1					
	C108		Capacitor, fixed, mica, 2100 µµf ±1%, 500V	Elmenco	CM-19A	S97-020	1					
	C109		Same as C108 except 632 µµf	Elmenco	CM-19A	S97-021	1					
	C110 C112 C160 C162		Same as C103 except 10 µµf	Elmenco	DM-15	S97-022	4	0	1			
	C111 C161		Same as C103 except 56 µµf	Elmenco	DM-15	S97-023	2					
	C113		Same as C105 except 0. 148 µf	Efcon	MHA	S97-024	1					
	C114		Same as C105 except 0. 04825 µf	Efcon	MHA	S97-025	1					
	C115		Same as C105 except 0. 01545 µf	Efcon	MHA	S97-026	1					

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	C116		Capacitor, fixed, mica, 4340 μμf ±1%, 500V	Elmenco	CM-30A	S97-027	1					
	C117		Same as C108 except 1300 μμf	Elmenco	CM-19A	S97-028	1					
	C118		Same as C116 except 4240 μμf	Elmenco	CM-30A	S97-029	1					
	C119		Same as C108 except 1350 μμf	Elmenco	CM-19A	S97-030	1					
	C120		Same as C108 except 430 μμf	Elmenco	CM-19A	S97-031	1					
	C121		Capacitor, fixed, mica, 136 μμf ±1%, 500V	Elmenco	CM-15A	S97-032	1					
	C122		Same as C121 except 40.5 μμf	Elmenco	CM-15A	S97-033	1					
	C123		Same as C108 except 2120 μμf	Elmenco	CM-19A	S97-034	1					
	C124		Same as C108 except 656 μμf	Elmenco	CM-19A	S97-035	1					
	C125		Same as C121 except 203 μμf	Elmenco	CM-15A	S97-036	1					
	C126		Same as C121 except 69.5 μμf	Elmenco	CM-15A	S97-037	1					
	C127		Same as C121 except 20.5 μμf	Elmenco	CM-15A	S97-038	1					
	C128		Capacitor, fixed, paper, 0.1 μf ±20%, 300V	Pyramid	7EPGIH	S97-039	1					
	C155		Same as C105 except 0.07325 μf	Efcon	MHA	S97-040	1					
	C156		Same as C105 except 0.0243 μf	Efcon	MHA	S97-041	1					
	C157		Same as C107 except 7570 μμf	Elmenco	CM-35A	S97-042	1					
	C158		Same as C108 except 2300 μμf	Elmenco	CM-19A	S97-043	1					
	C159		Same as C108 except 799 μμf	Elmenco	CM-19A	S97-044	1					
	C163		Same as C105 except 0.1565 μf	Efcon	MHA	S97-045	1					
	C164		Same as C105 except 0.0525 μf	Efcon	MHA	S97-046	1					

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				NAME	PART NO.			BASE SPARES	FIELD SPARES			
	C165		Same as C105 except 0.01635 µf	Efcon	MHA	S97-047	1					
	C166		Capacitor, fixed, mica, 4660 µµf ±1%, 300V	Elmenco	CM-19A	S97-048	1					
	C167		Same as C108 except 1420 µµf	Elmenco	CM-19A	S97-049	1					
	C168		Same as C116 except 6100 µµf	Elmenco	CM-30A	S97-050	1					
	C169		Same as C108 except 1860 µµf	Elmenco	CM-19A	S97-051	1					
	C170		Same as C108 except 577.5 µµf	Elmenco	CM-19A	S97-052	1					
	C171		Same as C121 except 186 µµf	Elmenco	CM-15A	S97-053	1					
	C172		Same as C121 except 47.5 µµf	Elmenco	CM-15A	S97-054	1					
	C173		Same as C108 except 2500 µµf	Elmenco	CM-19A	S97-055	1					
	C174		Same as C108 except 750 µµf	Elmenco	CM-19A	S97-056	1					
	C175		Same as C121 except 236 µµf	Elmenco	CM-15A	S97-057	1					
	C176		Same as C121 except 79 µµf	Elmenco	CM-15A	S97-058	1					
	C177		Same as C121 except 23.5 µµf	Elmenco	CM-15A	S97-059	1					
	C182		Capacitor, fixed, mica, 9190 µµf ±1%, 500V, TC = −40 to 0 PPM/°C	Cornell-Dubilier	1A	S97-060	1					
	C183		Same as C182 except 2960 µµf	Cornell-Dubilier	1A	S97-061	1					
	C184		Capacitor, fixed, mica, 910 µµf ±1%, 500V, TC = −40 to 0 PPM/°C	Cornell-Dubilier	5A	S97-062	1					
	C185		Same as C184 except 276 µµf	Cornell-Dubilier	5A	S97-063	1					
	C186		Same as C184 except 72 µµf	Cornell-Dubilier	5A	S97-064	1					
	C201		Same as C128 except 0.22 µf	Pyramid	7EPGIH	S97-065	1					

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	C202		Capacitor, fixed, paper, 0.05 μf ±20%, 200V	Pyramid	EPGIH	S97-066	1					
	C204		Capacitor, fixed, paper, 0.2 μf ±20%, 300V	Pyramid	EPGIH	S97-067	1					
	C205 C206		Capacitor, fixed, mica, 150 μμf ±5%, 500V	Elmenco	CM-15E	S97-068	2					
	C207		Same as C205 except 24 μμf	Elmenco	CM-15E	S97-069	1					
	C208		Same as C205 except 30 μμf	Elmenco	CM-15E	S97-070	1					
	C209		Capacitor, fixed, mica, 10 μμf ±5%, 500V	Elmenco	CM-15C	S97-071	1					
	C210		Capacitor, fixed, paper, 0.047 μf ±20%, 300V	Pyramid	EPGIX	S97-072	1					
	C301		Capacitor, fixed, mica, 0.002 μf ±10%, 500V	Elmenco	CM-20B	S97-073	1					
	C302		Capacitor, fixed, mica, 0.47 μf ±20%, 300V	Pyramid	7PGIH	S97-074	1					
	C303		Capacitor, fixed, mica, 3 μμf ±20%, 300V	Elmenco	CM-15E	S97-075	1					
	C304		Capacitor, fixed, paper, 0.1 μf ±20%, 600V	Pyramid	7PGIM	S97-076	1					
	C307		Capacitor, fixed, mica, 560 μμf ±10%, 300V	Elmenco	DM-15	S97-077	1					
	C308		Capacitor, fixed, paper, 0.47 μf ±20%, 200V	Pyramid	7PGIH	S97-078	1					
	CR101 CR102		Diode, germanium, 100V	Sylvania	1N38B	S97-079	2					
	F1		Fuse, 2.0 a	Littelfuse	313002	S97-080	*	2	2			*One supplied with 97H; two with 97G (one is a spare).
	F2		Fuse, 0.5 a	Littelfuse	313.500	S97-081	1	2	2			Used only on 97H.

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	I1		Bulb, pilot	GE	328	S97-082	1	1	1			
	I2		Bulb, neon	Dialco	NE2D	S97-083	1	1	1			
	J1		Connector, female, 32-pin	Cannon	DPD-D32C2-33S-1L	S97-084	1					
	L1		Reactor, filter, 12 h	Colin Campbell	L1855	S97-085	1			PP-LL		
	L101		Choke, rf, 7 μh	Ohmite	Z-50	S97-086	1					
	M101		Meter, 200 μa	Marion	0-10HS2 with spec. scale	S97-087	1			PP-LL		
	P1		Connector, male, 32-pin	Cannon	DPD-D32C2-34P-1L	S97-088	1					

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	R1		Resistor, fixed, wire-wound, 100Ω ±10%, 25W	Dale	B-25	S97-089	1					
	R2		Resistor, fixed, deposited carbon, 330K ±1%, 1/2W	Electra	DC1/2C	S97-090	1					
	R3		Resistor, fixed, wire-wound, 6.485K ±1%, 5W	Dale	RS-5	S97-091	1					
	R4		Resistor, fixed, wire-wound, 25K ±1%, 10W	Dale	RS-10	S97-092	1					
	R4A		Resistor, fixed, composition, 820K ±10%, 1/2W	Allen-Bradley	EB	S97-093	1					
	R5 R17		Same as R4A except 5.6K	Allen-Bradley	EB	S97-094	2					
	R6		Same as R4A except 270K	Allen-Bradley	EB	S97-095	1					
	R7		Same as R2 except 39K	Electra	DC1/2C	S97-096	1					
	R8		Resistor, fixed, molded deposited carbon, 150K ±1%, 1/2W	IRC	MDC	S97-097	1					
	R9		Same as R8 except 82K	IRC	MDC	S97-098	1					
	R10 R102 R111 R152 R161 R202 R208		Same as R4A except 1M	Allen-Bradley	EB	S97-099	7	1	1			
	R11 R124 R201		Same as R4A except 47K	Allen-Bradley	EB	S97-100	3	0	1			
	R12		Same as R4A except 10K	Allen-Bradley	EB	S97-101	1					

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				NAME	PART NO			BASE SPARES	FIELD SPARES			
	R13 R20		Same as R3 except 8K	Dale	RS-5	S97-102	2					
	R14		Same as R3 except 5.895K	Dale	RS-5	S97-103	1					
	R15		Same as R2 except 820K	Electra	DC1/2C	S97-104	1					
	R16 R309 R328		Same as R4A except 470K	Allen-Bradley	EB	S97-105	3	0	1			
	R18 R315		Same as R4A except 220K	Allen-Bradley	EB	S97-106	2					
	R19		Same as R3 except 10K	Dale	RS-5	S97-107	1					
	R21		Resistor, fixed, deposited carbon, 38.1K ±1%, 1W	Electra	DC1	S97-108	1					
	R22		Resistor, fixed, deposited carbon, 4.1K ±5%, 1/2W	Electra	DC1/2C	S97-109	1					
	R23 R200 R319		Same as R2 except 47K	Electra	DC1/2C	S97-110	3	0	1			
	R24		Same as R21 except 26.5K	Electra	DC1	S97-111	1					
	R25		Same as R2 except 120K	Electra	DC1/2C	S97-112	1					
	R26 R217		Same as R2 except 100K	Electra	DC1/2C	S97-113	2					
	R27 R28		Same as R4A except 68Ω	Allen-Bradley	EB	S97-114	2					
	R29		Same as R4A except 18K	Allen-Bradley	EB	S97-115	1					
	R30 R31		Resistor, fixed, wire-wound, 5.5K ±3%, 10W	Sage	S10W	S97-116	2					
	R32		Resistor, fixed, wire-wound, 5K ±5%, 10W	Milwaukee	Oval	S97-117	1					

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	R101		Resistor, variable, molded composition, 100K ±20%, 2W	Allen-Bradley	Type J	S97-118	1					
	R103 R153 R308 R325		Same as R4A except 100K	Allen-Bradley	EB	S97-119	4	1	1			
	R104 R154		Resistor, fixed, composition, 39K ±10%, 1W	Allen-Bradley	GB	S97-120	2					
	R105 R155		Same as R4A except 470Ω	Allen-Bradley	EB	S97-121	2					
	R106 R156		Resistor, fixed, composition, 33K ±10%, 2W	Allen-Bradley	HB	S97-122	2					
	R107 R117 R157 R167 R178		Resistor, variable, ganged, 20K-20K-20K-20K-200K ±2%	General Radio	Per EMR Dwg. B-02377	S97-123	1 Assy.			PP-LL		
	R108 R158		Same as R2 except 8K	Electra	DC1/2C	S97-124	2					
	R109 R115 R119 R159 R165 R169 R313		Same as R4A except 100Ω	Allen-Bradley	EB	S97-125	7	1	2			
	R110 R160 R316		Same as R4A except 1K	Allen-Bradley	EB	S97-126	3	0	1			
	R112 R162		Same as R4A except 820Ω	Allen-Bradley	EB	S97-127	2					

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	R113 R163		Same as R106 except 47K	Allen-Bradley	HB	S97-128	2					
	R114 R164		Same as R4A except 1.8K	Allen-Bradley	EB	S97-129	2					
	R116 R166		Resistor, fixed, molded metal film, 22K ±5%, 5W	Corning	LPI-5	S97-130	2					
	R118 R121 R168 R171		Same as R2 except 7.7K	Electra	DC1/2C	S97-131	4	1	1			
	R120 R170		Same as R106 except 39K	Allen-Bradley	HB	S97-132	2					
	R122 R172		Same as R2 except 2.7K	Electra	DC1/2C	S97-133	2					
	R123 R173		Same as R2 except 150Ω	Electra	DC1/2C	S97-134	2					
	R125 R314		Same as R4A except 4.7K	Allen-Bradley	EB	S97-135	2					
	R179		Resistor, fixed, molded metal film, 55K ±1%, 1W	Electra	MF1-T8	S97-136	1					
	R203		Same as R2 except 1.2M	Electra	DC1/2C	S97-137	1					
	R204		Same as R2 except 2.2M	Electra	DC1/2C	S97-138	1					
	R205		Same as R106 except 12K	Allen-Bradley	HB	S97-139	1					
	R206 R209		Same as R2 except 18K	Electra	DC1/2C	S97-140	2					
	R207 R210		Same as R2 except 180K	Electra	DC1/2C	S97-141	2					
	R211		Same as R2 except 65K	Electra	DC1/2C	S97-142	1					

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	R212		Same as R2 except 164K	Electra	DC1/2C	S97-143	1					
	R213		Same as R21 except 47K	Electra	DC1	S97-144	1					
	R214		Same as R21 except 18K	Electra	DC1	S97-145	1					
	R215		Same as R2 except 3.9K	Electra	DC1/2C	S97-146	1					
	R216		Same as R2 except 330K	Electra	DC1/2C	S97-147	1					
	R218		Same as R2 except 1.5M	Electra	DC1/2C	S97-148	1					
	R219 R220		Same as R4A except 3.3K	Allen-Bradley	EB	S97-149	2					
	R301 R303		Same as R4A except 120K	Allen-Bradley	EB	S97-150	2					
	R302		Same as R4A except 8.2K	Allen-Bradley	EB	S97-151	1					
	R304		Same as R106 except 22K	Allen-Bradley	HB	S97-152	1					
	R305		Same as R104 except 1.2K	Allen-Bradley	GB	S97-153	1					
	R306		Same as R104 except 18K	Allen-Bradley	GB	S97-154	1					
	R307		Resistor, fixed, wire-wound, 40K ±1%, 15W	Mepco	P-15	S97-155	1					
	R310 R311		Same as R179 except 150K	Electra	MF1-T8	S97-156	2					
	R312		Resistor, fixed, wire-wound, 30K ±3%, 15W	Mepco	P-15	S97-157	1					
	R317		Same as R2 except 300K	Electra	DC1/2C	S97-158	1					
	R318		Same as R2 except 220K	Electra	DC1/2C	S97-159	1					
	R320		Same as R2 except 140K	Electra	DC1/2C	S97-160	1					
	R321		Same as R2 except 82K	Electra	DC1/2C	S97-161	1					
	R322		Same as R2 except 4.7M	Electra	DC1/2C	S97-162	1					

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	R323		Same as R4A except 1.5K	Allen-Bradley	EB	S97-163	1					
	R324		Same as R4A except 560Ω	Allen-Bradley	EB	S97-164	1					
	R326		Same as R4A except 2.7K	Allen-Bradley	EB	S97-165	1					
	R327 R329		Same as R4A except 560K	Allen-Bradley	EB	S97-166	2					
	R330		Same as R4A except 12K	Allen-Bradley	EB	S97-167	1					
	R331		Resistor, variable, wire-wound, 5K ± 5%, 1.5W	Clarostat	49M-9	S97-168	1					
	R332		Same as R104 except 56K	Allen-Bradley	GB	S97-169	1					
	R333		Same as R106 except 120K	Allen-Bradley	HB	S97-170	1					
	R334		Same as R104 except 47K	Allen-Bradley	GB	S97-171	1					
	R335		Same as R4A except 1.2M	Allen-Bradley	EB	S97-172	1					
	R336		Resistor, variable, wire-wound, 50K ± 3%, 5W, 0.5% linearity	Beckman Helipot	A-R50KL.25	S97-173	1					
	S101		Switch, rotary, 9-section, 5-position	Centralab	Per EMR Dwg. B-02457	S97-174	1			PP-LL		
	S102		Switch, rotary, 6-section, 3-position	Centralab	Per EMR Dwg. B-02458	S97-175	1			PP-LL		
	SW1		Switch, toggle	Arrow-Hart & Hegeman	81024-F	S97-176	1					

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	T1		Transformer, power, with 4-μf capacitor (C15)	Colin Campbell	L2002	S97G-177	1			PP-LL		Used only on 97G.
	T1		Transformer, power	Colin Campbell	L1926	S97H-177	1			PP-LL		Used only on 97H.
	V1 V2		Tube, vacuum	Sylvania	5V4GA	S97-178	2	1	2			
	V3		Tube, vacuum	RCA	6080	S97-179	1	1	1			
	V4 V6		Tube, vacuum	Tung-Sol	6AW8A	S97-180	2	1	2	PP-LL		Aged at EMR.
	V5		Tube, gas	Raytheon	5651WA	S97-181	1	1	1			
	V101 V102 V151 V152 V304		Tube, vacuum	GE	6136	S97-182	5	2	2			
	V103 V104 V153		Tube, vacuum	GE	6201	S97-183	3	1	2			
	V201 V301 V302 V305		Tube, vacuum	RCA	6AU6	S97-184	4	1	2			
	V202		Tube, vacuum	RCA	6AL5	S97-185	1	1	1			
	V203		Tube, vacuum	RCA	5964	S97-186	1	1	1			
	V303 V306		Tube, vacuum	GE	5965	S97-187	2	1	2			

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	---		Fuseholder	Littelfuse	342003	S97-188	2					
	---		Jack, pin, red	E. F. Johnson	105-602-1	S97-189	1					
	---		Jack, pin, blue	E. F. Johnson	105-610-1	S97-190	1					